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ANALYSIS OF RETURN ON INVESTMENT FOR NAVAL AIR STATION FALLON ENERGY PROJECT ALTERNATIVES

by

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June 2017

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Energy Savings Performance Contracts (ESPC) are energy-related construction projects that are financed by a non–Department of Defense third party. This type of contract requires the contractor to perform the construction as well as the maintenance of installed equipment during the life of the financing agreement with the Navy. The Commander, Naval Installation Command (CNIC) must give approval for all Navy ESPC projects to proceed. CNICs are not provided future cost analysis to aid in deciding whether to approve or disapprove ESPC projects. Failure to approve the use of the ESPC for the required work will typically mean that the work must wait several years for appropriations funding to become available. During this time, the Navy will not realize the potential energy savings and associated benefits of the energy project. This analysis compares the Return on Investment for five energy project alternatives at Naval Air Station (NAS) Fallon, NV. Of these five, the ESPC alternative has the most benefit per this analysis, saving $1.3M over 20 years. CNIC can use these results to reinforce their decision to proceed with the NAS Fallon ESPC project.

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Energy Savings Performance Contracts (ESPC) are energy-related construction projects that are financed by a non–Department of Defense third party. This type of contract requires the contractor to perform the construction as well as the maintenance of installed equipment during the life of the financing agreement with the Navy. The Commander, Naval Installation Command (CNIC) must give approval for all Navy ESPC projects to proceed. CNICs are not provided future cost analysis to aid in deciding whether to approve or disapprove ESPC projects. Failure to approve the use of the ESPC for the required work will typically mean that the work must wait several years for appropriations funding to become available. During this time, the Navy will not realize the potential energy savings and associated benefits of the energy project. This analysis compares the Return on Investment for five energy project alternatives at Naval Air Station (NAS) Fallon, NV. Of these five, the ESPC alternative has the most benefit per this analysis, saving $1.3M over 20 years. CNIC can use these results to reinforce their decision to proceed with the NAS Fallon ESPC project.

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LIST OF ACRONYMS

CER	Cost Estimating Relationship
CFL	Compact Fluorescent Light
CNIC	Commander, Navy Installation Command
DOD	Department of Defense
DON	Department of the Navy
ECM	Energy Conservation Measure
ESCO	Energy Service Company
ESPC	Energy Savings Performance Contract
FY	Fiscal Year
HVAC	Heating, Ventilation, and Air Conditioning
IGA	Investment Grade Audit
LED	Light-Emitting Diode
LNG	Liquid Natural Gas
MBTU	Millions, British Thermal Unit
NAS	Naval Air Station
NAVFAC	Naval Facilities Engineering Command
NPV	Net Present Value
RMe	Restoration and Modernization, Energy
ROI	Return on Investment
SIR	Savings to Investment Ratio

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I. INTRODUCTION

Many Navy buildings have outdated equipment that waste energy in ways that could be minimized with modern equipment. A positive way of looking at this situation is to say that these buildings are a goldmine for future energy savings if the right investments are made to improve them now. Upon the recommendation of Naval Facilities Engineering Command (NAVFAC) Southwest, this paper will be an analysis of future energy costs that would be incurred in several scenarios at Naval Air Station Fallon (NAS Fallon), Nevada if a project recently under proposal, were not allowed to be awarded in its current form as an Energy Savings Performance Contract (ESPC). This analysis can support the decision-making process for similar future projects.

The Navy's budget requires NAVFAC to prioritize infrastructure restoration and modernization projects to decide which to fund and which to place on hold. Additionally, the Department of Defense (DOD) has been mandated to pursue energy reduction goals through decreased consumption and improvements in infrastructure. These two realities can often be at odds with one another. The Navy wants to reduce energy consumption in its buildings, but the necessary work to accomplish this is frequently low on the priority list and funding can be years away. In the interim, energy inefficiency continues to drain resources. ESPCs are a viable alternative to funding the work and because they are not an appropriation, these types of projects can come to execution more quickly.

ESPCs do deserve additional examination prior to approval since they are a way of financing a project rather than completely funding it up front. This type of contract will obligate the Navy to several years of compensation to the contractor who completes the work. The decision to finance a project can be difficult due to uncertainty of future funding availability. The decision to proceed with ESPCs is closely scrutinized, as it should be, however, excessive delays equate to missed-out energy savings while the project "green-light" waits. If a proposed project is rejected on the grounds of being financed, the work must wait several years while congressionally appropriated funds are requested. Potential energy savings are lost during this time.

This analysis can supplement the ESPC project proposal which only demonstrates the direct future benefits of proceeding with the project. The Commander, Naval Installation Command (CNIC) must approve all Department of the Navy (DON) ESPC projects. This analysis examines the following alternatives for comparison:

- Status Quo Alternative in which there is no action taken
- ESPC Alternative in which the ESPC is awarded
- Lighting Alternative in which only the lighting portion is awarded as a non-ESPC project
- HVAC Alternative in which only the HVAC portion is awarded as a non-ESPC project
- Lighting/HVAC ECM Alternative in which both portions are awarded as a combined non-ESPC project

This analysis provides CNIC with an estimate of the future costs of rejecting this ESPC project at NAS Fallon now and proceeding with any one of the other alternatives. Using raw data from many projects similar to the one in question, this analysis starts by developing a cost model to estimate the cost for NAVFAC to award the NAS Fallon project outside of an ESPC. Next, the energy savings from each alternative are calculated over the period of analysis for the project. Lastly, a Savings to Investment (SIR) ratio is developed for each alternative to find the best option. Ultimately, the analysis demonstrates that the ESPC alternative is the best course of action for the Navy with a SIR ratio of 1.25 as compared with the next best alternative of 1.01.

The rest of this analysis will proceed as follows. The background information discusses the Navy's current energy policies including the efforts to reduce shore-based energy consumption as well as the methods employed to achieve that goal. The literature review provides a short discussion on the merits of reduced energy consumption and the role that ESPCs play in that effort. Chapter III describes the sources of the raw data used to develop cost models as well as the way in which the cost models were developed and ranked. Chapter IV is the methodology used to develop the five alternatives under consideration and the assumptions that this analysis takes. Chapter V discusses the results of the analysis as well as the sensitivity of those results when the underlying assumptions are manipulated. Finally, the last chapter concludes this analysis.

II. BACKGROUND AND LITERATURE REVIEW

A. POLICIES FOR ENERGY MANAGEMENT

The Navy's energy policy is guided by several policy documents at the federal level, the DOD level, as well as at the DON level. The federal Energy Policy Act of 2005 was passed with the intent of improving energy efficiency in federal buildings and promoting use of renewable energy sources in those buildings. The policy also encouraged innovation in the field of energy production and distribution as a way of reducing energy demand by the federal government. In addition to the Energy Policy Act, Executive Orders have been issued in the past few decades that establish energy reduction goals for federal entities, including the DON.

The Secretary of the Navy announced the Great Green Fleet initiative in 2009, which lays out energy goals for the Navy that complement and amplify upon the energy goals of Congress. A few of the Great Green Fleet initiative goals (Secretary of the Navy [SECNAV] 2012) are:

- 50% energy consumption from alternative sources by 2020, DON-wide
- 50% of Navy and Marine Corps bases will be net-zero energy consumers by 2020
- Energy considerations will be required for systems and buildings contracts

The Resilient Energy Program Office is the DON organization tasked with executing projects that will meet the goals of the Great Green Fleet initiative. In 2017, the Resilient Energy Program Office was directed "to focus on installation energy resilience projects to capitalize on the office's industry relationships and expertise in third-party financing, energy systems and energy acquisition" (Resilient Energy Program Office [REPO] 2017).

At the installation level, Navy and Marine Corps bases are guided by OPNAV Instruction 4100.5E, *Shore Energy Management* (Department of the Navy [DON] 2012). This instruction provides policy that ensures energy security through the following three elements:

1. Ensure energy security as a strategic imperative: Energy supplies must be readily available to support shore and afloat missions. This means minimizing potential outages due to natural disasters as well as accidents or deliberate attacks on the electrical grid.

2. Achieve legal compliance for shore energy and sustainability: Installations will comply with laws and Executive Orders requiring energy intensity reductions in DON facilities. Installations will reduce reliance on fossil fuels while increasing use of renewable energy sources in order to decrease greenhouse gas emissions. Installations will employ systems and processes to increase awareness of energy consumption.

3. Achieve DON shore energy goals: The Navy will apply the Secretary of the Navy's Green Fleet goals to shore installations as part of the DON-wide strategy. The DON will cut energy consumption in half, increase alternative energy use to 50%, and achieve net-zero energy consumption at half of DON installations, all by 2020.

At most DON installations, there are additional energy goals and realities that are unique to the region and/or specific base location. Locations such as Hawaii and Guam tend to have high utility costs in comparison to other DON areas so these installations will strive to reduce their energy consumption. Other locations are prone to experience draught conditions for several years at a time. In all cases, Navy and Marine Corps bases work to be good neighbors by reducing consumption to minimize the impact on others while maintaining operational capability.

Managing the Navy's energy use ashore is not only a matter of reducing utility costs, but it also plays a crucial part in establishing energy security at installations. Energy security allows the Navy to have access to reliable energy sources that are less susceptible to natural and manmade disruptions to the energy grid. For shore installations, the Navy has three areas of energy focus: efficiency, culture and behavior, and renewable energy and sustainability. These focus areas are in line with the energy goals set out by the Secretary of the Navy in 2009. The DOD has several acquisition strategies to carry out shore energy management policy.

a. Installation Projects and Programs for Energy Management

(1) Energy Efficiency

In the 2015 *Shore Investment Guidance*, the Chief of Naval Operations stated "In our attempts to support our manpower and personnel budget, fund current and routine operations, and build the future Navy to respond to contingencies, we have deferred shore infrastructure investments" (SECNAV 2015). The Navy's existing installation infrastructure is vast and due to investment deferment, outdated. Outright replacement of major energy-consuming systems is expensive so a more cost effective strategy is to install upgrades to the existing equipment to make better use of it. A prime example would be to install modern controls on heating, ventilation, and air conditioning (HVAC) systems that allow the unit to operate only when a room is occupied vice operating on a schedule, even if a room is empty. Another example is to install insulation panels on exterior walls to make buildings more energy efficient.

Where new construction is required, the Navy has established stricter guidelines for energy efficiency than called for by the Energy Policy Act of 2005. This will mean adopting new and emerging technologies. Lighting is an example of one such new technology that is ready for adoption. Currently, the compact fluorescent light (CFL) is the standard lighting technology in most Navy buildings and due to lower consumption and a longer useful life, it is an improvement over the previous generation of incandescent bulbs. According to Shavers (2015), Light-emitting diode (LED) lights are the new Navy standard for lighting. LED lamps are typically more expensive than both CFL and incandescent lights, however, their energy consumption is approximately 25% less than the CFL lights and 85% less than the incandescent lights as illustrated in Figure 1.

Bulb Types (all approx. 800 lumens)	Life	Costs	Year 1	Cost Annually	Total Costs over 10 years
Standard Incandescent 60 W	1 yr	Bulb Cost	$0.50	$0.50	$5.00
		Energy Cost	$8.02	$8.02	$80.15
		Total Cost	$8.52	$8.52	$85.15
Halogen Incandescent 43 W	1 yr	Bulb Cost	$1.50	$1.50	$15.00
		Energy Cost	$5.74	$5.74	$57.44
		Total Cost	$7.24	$7.24	$72.44
CFL 13 W	9 yrs	Bulb Cost	$3.00	$0.00	$6.00
		Energy Cost	$1.74	$1.74	$17.37
		Total Cost	$4.74	$1.74	$23.37
LED 10 W	23 yrs	Bulb Cost	$13.00	$0.00	$13.00
		Energy Cost	$1.34	$1.34	$13.40
		Total Cost	$14.34	$1.34	$26.40

Source: National Resource Defense Council (2016).

Figure 1. Comparison of Bulb Costs.

The benefit of improving energy efficiency in the DON's existing infrastructure is real and significant as demonstrated by the progress made so far. By 2009, the DON had achieved a 15.2% reduction, largely from energy efficiency improvement (SECNAV 2012). For comparison, the Energy Policy Act of 2005, Pub. L. No. 109–58, 119 Stat. 594, set a goal of reducing energy consumption 12% per square foot by the year 2009 with 2003 as the baseline. The Navy has exceeded that goal and will continue to reduce its energy consumption.

(2) Culture and Behavior

In the past, not much thought was given to the cost of leaving a light on in an unoccupied room because energy consciousness was not part of the culture of the Navy. Now, this problem is overcome with the introduction of occupancy sensors that will turn off lights when no motion is detected. Other energy management scenarios might not have such a simple solution. In those cases, the Navy must rely on its people to identify and act upon correcting or avoiding wasteful energy use. The most important step to get people on board with an energy conscious culture is to make them conscious of the problem. This may mean formal or informal training/discussions of the Navy's energy goals. Policies are in place that give employees guidance on energy conservation measures such as shutting off computers at night or prohibiting personal space heaters which are high energy users.

Where policies fall short, physical controls are enacted to prevent energy waste. Many Navy buildings have room thermostats that can be manually adjusted locally. The temperature in a room is set to balance the comfort of occupants against the cost of operating the HVAC system. To prevent occupants from continually adjusting the temperature, ventilated clear plastic locking covers are installed over the thermostat. While effective, this solution is not fool-proof. A clever person who wants to turn on the heat might decide to put an ice-pack on top of the thermostat cover, thus tricking the system into prematurely turning on. This is where an energy advocate in the building is needed.

The Building Energy Monitor is an employee within a building who typically volunteers for the role of promoting and sustaining energy conservation initiatives amongst his or her local peers. The Building Energy Monitor receives training on how to manage energy as well as what problems to look for and possible solutions. The Building Energy Monitor will periodically conduct energy inspections within the building and report their findings up the chain of command. When energy repairs or upgrades are identified by the Building Energy Monitor, they can be submitted for correction. The Building Energy Monitor program is highly effective because it puts a person in place to hold others accountable for their energy choices.

(3) Renewable Energy and Sustainability

Improving energy efficiency in the Navy's infrastructure and changing the energy culture are important first steps in gaining energy security. Another key component to ensuring energy security is energy production. Whereas the electrical grid relies predominately on fossil fuels for electricity production, the Navy is pursuing energy from renewable sources. This tactic means that the Navy's energy needs are met by sustainable resources such as the sun, wind, and geothermal sources. Additionally, federal law and Executive Orders state that the DOD will reduce its dependence on fossil fuels.

Several renewable energy sources are available to the Navy. The simplest source of renewable energy is solar photovoltaic. These solar photovoltaic arrays can easily be placed in open space to capture sunlight, primarily rooftops. Wind energy is another promising source of energy, however, its use is limited to certain locations based on wind patterns as well as Navy operation requirements such as clear flight paths. Some DON locations have geologic conditions that make geothermal energy possible and practical. The capital expense for a geothermal plant is high, however, the power generation is immense and it does not suffer from some of the shortfalls of solar and wind energy.

b. Acquisition Tools and Methods for Installation Energy Management

The NAVFAC *Energy Project Management Guide for Navy and Marine Corps Projects* provides guidance and standardization for developing and managing DON energy projects. It states that a key premise of any energy project is that payback must occur during the lifetime of the project. That is, the cumulative financial savings from reduced energy consumption (compared to pre-project energy use) over the life of the project must be greater than the cost to complete that project. Project developers assess the viability of a project under this metric by performing a life-cycle cost analysis of the project.

The life-cycle cost analysis will tell the developer whether a project pays for itself over its lifetime, provides a payback timeframe, provides a savings to investment ratio, as well as other useful decision making information. If the lifetime benefits exceed the costs, the project is considered viable, but that does not mean it will be carried out. All Navy projects must compete for funding so the Energy, Return on Investment metric is used to find the most beneficial projects. The next step is to develop the DD1391 for the top energy projects so that funding can be requested. The DD1391 is the standard DOD form used to thoroughly describe the scope of a construction project as well as its estimated costs. Several funding options exist for carrying out DON installation energy projects.

(1) Energy Conservation Investment Program

The Energy Conservation Investment Program is a subset of the Military Construction program. This funding is a congressionally funded set aside for energy projects that meet the criteria for Military Construction projects, namely price threshold. This funding option pays for the project up front, however, the timeline from project conception to project execution is quite long, often four or five years.

(2) Restoration and Modernization, Energy (RMe) and Energy Investment Program

RMe is a congressionally funded set aside from O&M,N funds. The Energy Investment Program is the Marine Corps equivalent. Both funds are specifically meant for energy retrofit projects. Just like the Energy Conservation Investment Program funding, these funds pay for a project up front and are the preferred funding method if a project meets their criteria. The key criteria are that a project's cost must be less than the current Military Construction threshold.

(3) Third-Party Financing

Third-party financed projects do not require a congressional appropriation and can be developed and executed relatively quickly. The two types of financed projects that the DON uses are Utility Energy Service Contracts and ESPCs. In the case of the Utility Energy Service Contracts, a utility provider finances the energy project and the Navy pays for the project over several years, typically as part of the utility bill. An ESPC project is financed by the contractor performing the work. The contractor guarantees a certain annual energy savings because of their work. The Navy installation uses the annual savings from its energy budget to pay back the contractor. ESPCs include contractor performance guarantees as well as contractor provided operational and maintenance support during the financing period. Utility Energy Service Contracts do not have these guarantees or support.

B. DEVELOPMENT OF NAS FALLON ENERGY PROJECT

In keeping with the energy goals of the Navy, NAS Fallon Public Works put together an energy project that would be done using third-party financing via an ESPC. The Navy partnered with Ameresco, Inc., an Energy Service Company (ESCO), to perform an Investment Grade Audit (IGA) of several dozen buildings aboard NAS Fallon. The ESCO was tasked with surveying buildings and developing cost effective Energy Conservation Measures (ECM) for lighting and climate controls. The final IGA report identified opportunities for lighting energy improvements in 45 buildings and HVAC energy improvements in 18 buildings. The IGA report also serves as a final cost proposal by the ESCO for consideration of awarding the construction phase of the project. The IGA report is found in the Appendix.

Between the two ECMs, the ESCO guaranteed an annual reduction in energy of 26,105 MBTU/year based on a 2015 energy baseline. From the IGA report, this energy project represents a 13.3% reduction in NAS Fallon's energy intensity based on the 2015 energy baseline of 196,053 MBTU used. The lighting ECM accounts for 2.1% (15.8% of the total) of this while the HVAC ECM accounts for 11.2% (84.2% of the total) of the reduction.

From the IGA report, the Navy prepared a Request for Proposal for Task Order N39430-14-F-FALLON, *Energy Savings Performance Contract Naval Air Station Fallon, NV*.

a. Scope of Work for Lighting ECM

Section C2.1.1 of the Navy's Task Order for this energy project includes the lighting ECM requirements section of the contract being considered for award. It is largely based upon the IGA report prepared by the ESCO. The requirements call for the ESCO to carry out several thousand lighting improvements in 45 buildings. This includes all required wiring, switches, and associated mounting hardware. Table 1 is an itemized list of required components.

Table 1. Estimated Listing of Replacement Lamps and Fixtures by Type.

Lamps	QTY
1L EMERGENCY BALLAST	12
Install 11w LED Circular Round Fixture	38
Install 150w LED High Bay	4
Install 150w LED Pool High Bay	38
Install 16.5w LED PAR 38 Screw in	145
Install 2 - 9w LED A19 Screw in	6
Install 9w LED A19 Screw in	324
Install 9w LED MR-16 Lamp	141
Install LED Exit Sign	13
Relamp with 2 - 28w LED T5 LED Tube	124

Lamps	QTY
Relamp with 4 - 28w LED T5 LED Tube	208
Relamp with 6 - 28w LED T5 LED Tube	24
Remove Ballast Replace Tombstones and Install 1 13w 4’ Direct Wire Tube	282
Remove Ballast Replace Tombstones and Install 1 8w 2’ Direct Wire Tube	263
Remove Ballast Replace Tombstones and Install 2 11w 3’ Direct Wire Tube	109
Remove Ballast Replace Tombstones and Install 2 13w 4’ Direct Wire Tube	4663
Remove Ballast Replace Tombstones and Install 2 8w 2’ Direct Wire Tube	117
Remove Ballast Replace Tombstones and Install 2 8w 2’ Direct Wire Tube and a 3 Lamp Reflector	356
Remove Ballast Replace Tombstones and Install 3 13w 4’ Direct Wire Tube	895
Remove Ballast Replace Tombstones and Install 3 8w 2’ Direct Wire Tube and a 3 Lamp Reflector	25
Remove Ballast Replace Tombstones and Install 4 13w 4’ Direct Wire Tube	453
Remove Ballast Replace Tombstones and Install a Strip Kit with 2 13w 4’ Direct Wire Tube	2
Remove Ballast Replace Tombstones and Install a Strip Kit with 4 13w 4’ Direct Wire Tube	76
Retrofit with 28w Retrofit Kit	26
Total Improvements	**8,344**

Source: Naval Facilities Engineering Command (NAVFAC) (2016).

b. Scope of Work for HVAC ECM

Section C2.1.2 of the Navy’s Task Order for this energy project includes the HVAC Controls and Motors Improvements ECM requirements section of the contract being considered for award. These improvements will take place in 18 buildings and include eight types of upgrades as detailed in Table 2. The types of upgrade are summarized from the energy project Task Order.

Table 2. Buildings Included for HVAC Controls and Motors Improvements.

Bldg	Description	Sq. Ft.	Equip. Schedul-ing & Reset	VFDs: Fan Motors & Pumps	Central Plant Optimiz-ation	Hot Water Reset	VAV System Convers/ Occ. Controls	Demand Control Ventila-tion (DCV)	RTU Ctrl	Static Pressure Reset
4	Hangar 7	39,857	X							
42	Hangar 4	35,867		X						
300	Hangar 1: Ground Support Equipment	80,661	X	X				X	X	
307	Public Works ROICC Admin	25,296	X							
308	Recreation Bldg	27,248	X	X						
324	Officers Club - Silver State	10,958	X	X		X			X	
341	Navy Exchange: Main Store	20,338	X	X					X	
350	Administration Building		X							
351	Chapel	8,762							X	
383	MWR Indoor Pool	14,170				X				
387	MWR Movie Theater		X					X	X	
404	Hangar 5	59,138	X	X						
406	FTB Applied Instruction Bldg	44,668	X	X			X	X		X
431	Hangar 2	68,995	X	X		X				
462	Hangar 3	36,675	X			X				
465	NSAWC Applied Instruction Bldg	61,060	X		X	X	X			X
466	Control Tower	5,964		X						
3100	Fitness Center						X			

Source: NAVFAC (2016).

(1) Scheduling and Reset

Each of the 18 buildings in this ECM will receive a new building level controller that can integrate with the existing HVAC controls equipment in a building. The building level controller will receive input from sensors such as a thermostat and issue commands to controllers on airflow dampers, for example, to adjust heating or cooling in a room. The building level controller in each building will use control strategies from the previous building level controller or the ESCO will adjust the programming for more efficient operation. This building level controller will have a web user interface that allows NAS Fallon to centrally monitor building operations that are incorporated into the building level controller as well as adjust its programming logic as needed.

(2) Variable Frequency Drives: Fan Motors & Pumps

Most NAS Fallon buildings have HVAC systems that use boilers and chillers to heat or cool water that is then pumped to air-handling units where air supply fans operate. Currently, all pump and fan motors operate at full capacity in their "On" status, regardless of heating and cooling demands. The ESCO will install variable frequency drives on 23 hot or cold water pump motors and supply fan motors. The motor variable frequency drives will rely on pressure sensors to modulate the pump and fan speeds.

Variable frequency drives modulate the operating speed of the motors, which allows the motors to ramp up more slowly and operate at a lower output and therefore at a lower energy consumption than previously. The relationship between output and energy consumption is non-linear, and motors vary, but in general, a motor operating at 50% capacity will require much less than 50% of its full-capacity energy consumption. A variable frequency drive will cause a pump or fan motor to run for longer periods of time, but the increase in operating time is more than offset by energy consumption savings of operating at lower outputs.

(3) Central Plant Optimization

Most buildings have decentralized heating and cooling systems, however, one centralized cooling plant will receive new temperature and flow sensors and optimized operating sequences.

(4) Hot Water Reset

Boilers are more efficient the lower the temperature of the returning water. Currently, most NAS Fallon buildings' boilers supply temperatures dynamically vary based on outdoor air temperature rather than actual heating demand at the end-use equipment. The result is that heating zones have their heating control valves most of the way closed since the zone does not require as much heat as is being supplied from the boiler supply. Return water returns to the boiler with much of the thermal energy that it left with on the supply side. The new scheme will dynamically reset the boiler supply temperature based on the heating needs of the highest demand area.

(5) Variable Air-Volume System Conversion and Occupancy Control

Variable air-volume systems change the airflow to individual rooms or zones by adjusting the fan speed of the air-handling unit and adjusting damper positions in the zonal variable air-volume box. Currently, the heating and cooling of zones is based on programmed occupation hours of the zones. Some buildings zones have prolonged periods of being unoccupied; classrooms and the gym. The ESCO will install occupancy sensors in these areas to control the temperature of the space.

(6) Demand Control Ventilation

Temperature is not the only quality of air that needs to be controlled. Air-handling units must take in outside air to refresh the air that occupants breathe. Most air-handling units will have a constant flow of outside air mixing with recycled indoor air. The fresh outside air adds heating and cooling requirements on the system. CO_2 sensors can be added to occupied spaces to test the quality of the air. If occupancy is low in a room, less outside air needs to be drawn in which means less heating or cooling of unconditioned outside air.

(7) Rooftop Unit Controls

Several NAS Fallon buildings use rooftop units rather than boilers/chiller air-handling unit systems. These rooftop units use outdated control logic and constant supply fan speeds. New rooftop unit controls can be added to the units that control fan speeds, control outside air requirement and economize operations of the rooftop unit.

(8) Static Pressure Reset

Variable air-volume air-handling units vary fan speeds to get a constant static pressure in supply ductwork. During low air-handling unit load periods, dampers in zonal variable air-volume boxes move toward the closed position to decrease airflow into a zone. The static pressure of the system can be adjusted down via a variable frequency drive on the fan motor during these low loading periods, thus saving energy. Dampers in zonal variable air-volume boxes would remain closer to the open position. This static pressure reset logic will be incorporated into the air-handling unit controls.

c. Post-construction Requirement

(1) Commissioning

Both ECMs will be commissioned upon completion, prior to acceptance by the Navy, to ensure that all equipment and operations sequences are operating as designed to meet the ESCO's performance guarantee.

(2) Measurement and Verification

Section C.16 of the Navy's Task Order for this energy project concerns the ESCO's performance guarantee. It states:

> A major tenet of this task order, issued under the DOE's Master IDIQ ESPC, is the performance guarantee. The contractor guarantees the performance of the newly installed ECMs covered under this task order to generate, at a minimum, the cumulative annual ECM savings guaranteed in each performance period (as shown in TO-4 Schedule). By law, the contractor guarantees that the Government's total utilities costs after implementation of the ECMs covered under this task order will be less than the costs to the government had no task order been issued. (NAVFAC 2016)

To abide by this performance guarantee, the ESCO will need to perform measurement and verification at defined times from just after installation up to the end of the ESPC finance period. The ESCO will perform measurement and verification in accordance with standards set by the Department of Energy's Federal Energy Management Program.

Baselines for measurement and verification were established in the ESCO's IGA report. The first measurement and verification phase occurs concurrently with commissioning and in many ways, the two are the same. Annually, the ESCO will perform measurement and verification of a similar nature to the first phase. Every fifth year, the ESCO is required to perform the standard annual measurement and verification as well as certain higher order checks of installed equipment. Results of the measurement and verification will be compared to baseline parameters.

For the lighting ECM, measurement and verification will look at wattage, light levels, and hours of light operation to name a few. For the HVAC ECM, measurement and verification will use trended data collected by building level controllers to monitor the operation of HVAC components. building level controllers will measure and record data from rooftop units, boilers, variable air-volume systems, and air-handling units every 15 minutes.

(3) Maintenance and Repair/Replacement of ECMs

For the duration of the ESPC finance period, the ESCO is responsible for the maintenance and repair or replacement of all ECMs installed in this energy project. The ESCO is required to maintain any ECM equipment per the product manufacturer's standard. The ESCO is not responsible for maintenance of equipment that was installed prior to this energy project to which an ECM was performed such as air-handling units. The Navy is responsible for that maintenance.

C. LITERATURE REVIEW

Although a literature review is not typically called for in a cost-benefit analysis such as will be presented later, there is plenty of literature published that extols the need for energy use reduction and efficiency at military installations. There is also an emerging trend in the use of financed construction projects such as the ESPC. This brief literature review will present literature regarding each of these items.

In *Power Begins at Home: Assured Energy for U.S. Military Bases*, the authors discuss the current and future energy security challenges faced by U.S. military bases and installations (Marquesee et al., 2017). These bases typically receive power from the local utility and in an outage, the base has backup energy systems that can sustain critical systems for a limited time. The current source of backup power is often diesel generators that power individual buildings. The authors recommend a shift toward large-scale microgrids that interconnect the facilities of an installation so that multiple backup power sources can be used flexibly and economically across the installation, rather than in a single location. Aside from using larger, centralized diesel generators in the microgrid, renewable energy sources such as solar and wind power can be incorporated into the microgrid.

The authors point out that one economical way to make the microgrid more effective and less costly is to invest in building energy renovations. By reducing energy consumption at an installation, less backup power is needed in the microgrid. The authors see one limiting factor to energy renovations as coming from Congress and DOD's hesitance to use third-party financing in conjunction with appropriated funding. Energy efficiency improves energy security and it can be helped along by using third-party financing to implement energy projects.

In *Beyond Guaranteed Savings: Additional Cost Savings Associated with ESPC Projects*, Shonder (2013) makes several points about ESPC project energy savings that are not understood well enough to fully appreciate the benefits of ESPC projects. The ESPC is guaranteed by contract to result in a certain level of annual energy savings. The author shows that the actual annual energy savings exceed the guaranteed amount.

1. The ESPC contractor only guarantees 96% of the calculated energy savings in order to leave a buffer. This means the government actually saves more than the ESPC guarantees it to save.
2. Equipment installed in an ESPC project has a useful life that extends well beyond the financed period of an ESPC project.
3. The utility escalation rates calculated by the National Institutes for Standards and Technology have historically been conservative when compared to actual energy price increases.
4. In preparing the guaranteed energy savings estimate for an ESPC project, the contractor uses current equipment energy usage rates as the baseline for comparison throughout the period of the ESPC project. Degradation of the existing equipment is not included for cost consideration, although this equipment would have decreasing efficiency and increased sustainment costs.

The author suggests that these four points reveal there are additional energy and cost savings that are not considered when deciding on the use of ESPC to perform a project.

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III. DATA AND DERIVATION OF COSTS AND BENEFITS

The first goal of this analysis is to derive a cost model to estimate the cost to the Navy of funding this energy project with RMe funds. This estimate will be compared to the cost of awarding the project as an ESPC to the ESCO. This chapter will identify the sources of data used to calculate costs and benefits for this Return on Investment (ROI) analysis. In this analysis, facilities' construction costs are the *investment*, and savings from reduced utility costs are the *return*. FY17 is the base year for this analysis.

A. FACILITIES INVESTMENT COSTS

1. ESPC Cost

The Investment Grade Audit contained in the Appendix is the basis for the ESPC costs. The Navy will make annual payments to the ESCO starting in FY18 and continuing until FY28. By contract, the annual savings in utility costs are guaranteed to exceed each of these annual payments to the contractor. The annual payments include the implementation costs (principal and interest for implementation) as well as post-acceptance sustainment costs (maintenance and repair, etc.).

Table 3 summarizes the ESPC project's work requirements and costs associated with the lighting and HVAC ECMs within the ESPC alternative. These estimates were prepared by the ESCO. The first row in the table, Project Development, shows the costs to the ESCO to conduct the energy survey at NAS Fallon and develop a proposed solution. The total cost to carry out the Project Development was $105,291 which includes direct and indirect costs as well as profit for the effort. The cost of the project development is common under all alternatives since the work was completed at the request of the Navy. The second and third rows show the Lighting ECM costs and HVAC ECM costs. These two items have direct and indirect costs, profit, as well as costs for measurement and verification. Measurement and verification is the quality control work that takes place following construction. If the ESPC alternative is selected, the cost of the Project Development is combined with the implementation cost and paid back during the finance period. The two ECMs are listed and their costs are broken down into direct and indirect cost as well as profit. The principal portion of the financed implementation cost also includes the ESCO's Finance Procurement Price.

Table 3. Work Requirements and Cost for ESPC Implementation, FY17$.

Work Requirement	M&V Expense	Direct Cost	Indirect Cost	Profit	Totals
Project Development	--	85,630	13,701	5,960	105,291
Lighting ECM	2,258	731,748	117,441	51,087	902,534
HVAC ECM	8,782	2,846,031	456,770	198,695	3,510,278
Implementation	11,040	3,663,408	587,912	255,742	4,518,102
Finance Procurement Price					358,197
Total Procurement Cost					4,876,299

Adapted from Investment Grade Audit found in the Appendix.

Table 4 shows the annual payments in FY17$ by the Navy to the ESCO for the financed implementation cost and includes interest. These payment amounts are used as the *NPV(Investment)* for the ESPC alternative in this analysis. The annual payments in Table 4 as well as their respective Interest/Principal ratios were established by the ESCO.

Table 4. Annual Finance Payments for ESPC Implementation, FY17$.

	Principal	Interest	Total
FY18	478,624	15,144	493,768
FY19	346,806	148,522	495,328
FY20	351,764	145,171	496,935
FY21	370,300	128,289	498,589
FY22	389,175	111,115	500,290
FY23	408,394	93,645	502,039
FY24	427,965	75,871	503,837
FY25	447,894	57,789	505,683
FY26	426,262	39,392	465,653
FY27	445,274	22,264	467,538
FY28	124,308	4,833	129,141
Total	4,216,766	842,035	**5,058,801**

Adapted from Investment Grade Audit found in the Appendix.

2. CNIC ECM Facilities Investment Costs

The estimated costs of each ECM in the ESPC were provided by the ESCO, while the cost for the Navy to conduct the same work in each ECM using RMe funding must be derived from existing CNIC Lighting and HVAC ECM data. In order to derive these implementation costs to the Navy, the existing CNIC ECM data will be used to develop cost models for each ECM. There will ultimately be two cost models chosen from among several viable cost models; one for the Lighting ECM and one for the HVAC ECM. These models will be developed using multivariate linear regression in which *Cost* is the dependent variable. The independent variables will be energy savings of the ECMs and the area of the building(s) improved by the ECM. These models are referred to as Cost Estimating Relationships (CER) because the dependent variable *Cost*, is driven by the independent variables.

The following section will further discuss the CNIC provided ECM data. Next, there will be a description of the derivation of the CERs from this data. The derivation process involves the following basic steps:

- Calculate indirect costs associated with the raw data

- Perform multivariate linear regression to derive several possible CERs for each ECM
- Compare the various CERs for each ECM using statistical analysis and choose the best models
- Use best CERs for Lighting ECM and HVAC ECM to calculate the expected implementation costs for the NAS Fallon ECM.

The calculated implementation costs will eventually be used in Chapter IV, *Methodology*, to calculate ROIs for some of the project alternatives that were introduced in the opening chapter.

a. Source of Costs

For this analysis, CNIC provided a dataset of 63 energy projects at Navy installations within the U.S. and overseas that have been planned and estimated for inclusion in FY17/FY18 budgets. The cost estimates for these energy projects were conducted by NAVFAC in accordance with the Unified Facilities Criteria (UFC) standards established and published for DOD agencies. NAVFAC uses the publication *UFC 3–740-05, Handbook: Construction Cost Estimating* to estimate the direct planning and construction costs of a project. The scope of these 63 energy projects involves lighting and HVAC work only. Within the dataset, each energy project is broken down into its many individual tasks such as replacing a specific lighting ballast in a building or resetting the HVAC controls within an area of a building. These individual tasks are the data points within the overall dataset. In total, there are 871 individually cost estimated data points for the 63 projects within the CNIC dataset provided.

For the lighting portion of these projects, there are 683 individually cost estimated data points. These data points vary in nature, but are all related to lighting energy improvements and are comparable to the scope of the NAS Fallon lighting ECM which includes a wide variety of lighting improvement elements. For the HVAC portion of these projects, there are 188 individually cost estimated data points. These data points also vary in nature, but again, they are all related to HVAC energy improvements and are comparable to the scope of the NAS Fallon HVAC ECM

Each of the 871 data points in the dataset contains several important pieces of information, including:

- Project number, location, and year of implementation
- Description (“Replace CFL tube with LED,” “Replace thermostat,” etc.)
- Estimate of direct cost for individual data point (i.e., cost to replace CFL tube with LED)
- Energy savings from electricity (kWh/year) and/or liquid natural gas (LNG) (MBTU/year)
- Square footage of building(s) impacted by data point (data points may represent one or more buildings)
- Administrative, contingency, and design cost factors for project location

b. Derivation of Cost Models for NAS Fallon Energy Project

For each ECM, a separate CER model was developed to estimated how much the Navy would likely spend to plan, design, and implement the NAS Fallon energy project. Each CER assumes that the Navy would develop the energy project to have the same scope of work that the ESCO developed for the ESPC alternative and that the annual energy savings would match the ESPC energy savings for each ECM. A detailed description of the CER derivation process follows.

(1) Raw Data Preparation

To develop the CERs for the NAS Fallon energy project, the direct costs for all 871 lighting and HVAC data points in the dataset were normalized to FY17$. Indirect costs were included by applying cost factors to the estimated direct costs from the data points. NAVFAC establishes these cost factors as a percentage of the direct planning and construction costs for projects. The indirect costs include administrative, contingency, and design costs associated with the project. This gave the total cost of each individual lighting or HVAC data point.

The summary statistics for the data are shown in Table 5. The area and energy values have a very large spread, however, this is natural given the differences from one project to the next within the data set. A more useful measure of data variation is found by dividing the *Implementation Cost* of a data point by its corresponding *Annual Energy Saved* to get the *Cost per MBTU Saved Annually* as shown in the rightmost column of Table 5. Ideally, we would generally expect to pay the same amount for each unit of energy saved annually in a project.

Table 5. Summary Statistics for Lighting and HVAC Data

		Implementation Cost, FY17$	Area, SQFT	Annual Energy Saved, MBTU	Cost per MBTU Saved Annually, FY17$
Lighting ECM	Average	29,419	56,182	74	519
	St. Dev.	146,941	366,614	253	1,530
	Min	9	48	0	9
	Max	2,938,490	9,368,550	4,130	26,305
	Data points	683	683	683	683
HVAC ECM	Average	212,327	47,159	942	386
	St. Dev.	535,933	63,347	1,872	613
	Min	992	876	1	3
	Max	5,420,000	450,000	13,648	7,211
	Data points	188	188	188	188

Adapted from Commander, Navy Installation Command (CNIC), unpublished data.

It is worth noting that the max *Cost per MBTU Saved Annually* for the Lighting ECM dataset is 26,305 and in fact, this value appears twice in the dataset. In the dataset, these values appear suspicious and possibly erroneous. Each of these data points saves only1.5 MBTU annually at an implementation cost of $39,500, however, the area in one of the data points is much greater than the other; 424,000 SQFT versus 163,000 SQFT. When removed from the dataset, the new mean for *Cost per MBTU Saved Annually* drops to $443/MBTU-saved and the standard deviation is less than half of the value shown in Table 5. For the HVAC ECM dataset, there is one *Cost per MBTU Saved Annually* data point that is suspiciously high and when it is removed, the mean drops slightly and the standard deviation is cut in half. For regression analysis, regression was done with and without the suspicious data points and the results were effectively the same. For that reason, the suspicious data points were ultimately left in the dataset.

(2) Regression of Data

In order to estimate the costs of implementing lighting and HVAC ECMs, we built multivariate linear regression models of the following form:

$$Y_i = \alpha + \beta_1 area_i + \beta_2 energy\_saved_i + e_i \tag{1}$$

Where

- Y_i is the expected cost of implementation for the lighting or HVAC ECM for project i
- $area_i$ is the area of building(s) (SQFT) improved by the ECM
- $energy\_saved_i$ is the energy saved annually (MBTU) by the ECM
- e_i is the error term

The coefficients $ß_i$ represent the incremental change in cost Y_i for a unit change in the corresponding variable. For example, a positive $ß_2$ indicates an increase in Y_i from a unit increase in the variable *energy_saved*. Initially, dummy variables were included in the regression models to account for geographic region and specific installation location. These variables proved to be statistically non-significant so these variables were stripped out of the models. From the regression output, each CERs' statistics and significance were scrutinized and compared against one another to find the best one.

(3) Compare Regressed CERs

We applied the following steps:

- Using a significance level of 0.20, the significance of the F-statistic was used to determine if a CER provided a statistically significant model.
- Individual variables' t-stat significance was tested at a 0.20 significance level to determine if the model was still statistically significant.
- For CERs still under consideration, their R-Square Values, and Standard Errors were used to rank the models.

- CERs were tested for multicollinearity using a pair-wise correlation matrix to determine if variables are statistically independent. Correlations greater than 0.70 ($r \geq 0.70$) are considered high correlation.

For each ECM, the highest ranking CER that passed the significance tests and correlation test was chosen as the best model.

(4) Calculate ECM Implementation from Best CER

From the regression analysis and testing of the CERs, the best model for the lighting ECM cost included variables for area of the building(s) affected by the ECM and the expected annual energy savings from the ECM.

The best model for the HVAC ECM cost included only the variable for expected annual energy savings of the ECM. Table 6 shows the best ECM models and includes statistical data used in determining the best model.

Table 6. Best CERs for Lighting and HVAC ECMs.

Best Lighting ECM Cost Estimation Relationship					
Cost = -3942.112 + 0.167*(area) + 322.52*(energy_saved)					
Signifance F	P-value, area	P-value, energy_saved	R Square	Standard Err.	Correlation
3.43E-223	1.62E-58	1.21E-90	0.78	$69,283	0.64
Best HVAC ECM Cost Estimation Relationship					
Cost = 40991 + 181.951*(energy_saved)					
Signifance F	R Square	Standard Err.			
1.1602E-22	0.40	$414,890			

Adapted from CNIC, unpublished data.

The IGA report indicates that the total area of all buildings included in the lighting portion of the NAS Fallon energy project is 1,153,883 SQFT, and the expected energy savings associated with the lighting ECM is 4,055 MBTU (1,188,132 kWh). The total area of all buildings included in the HVAC portion of the NAS Fallon energy project is 583,113 SQFT. The expected energy savings associated with the HVAC ECM is 17,023 MBTU from LNG and 5,026 MBTU (1,472,842 kWh) from electricity for a total of 22,049 MBTU.

For the CERs, the e*nergy_saved* variable is in MBTU so electricity use has been converted from kWh to MBTU to be used in the models. Using the area value of 1,153,883 SQFT and the expected energy savings of 4,055 MBTU, the lighting CER in Table 6 gives the expected project cost for the NAS Fallon lighting ECM as **$1.5M**. Similarly, the expected project cost for the HVAC ECM is **$4.1M**. Therefore, the total expected project cost for both ECMs when funded by RMe is **$5.6M**. Source of energy savings values are discussed in the next section.

All RMe implementation costs are incurred by the Navy in the FY that the project is awarded. In addition to the expected cost of implementing the ECMs, all non-ESPC alternatives will include the cost incurred by the ESCO in preparing the IGA report. This cost is shown in Table 3 as $105,291 and will be paid to the ESCO in FY17 if any alternative other than the ESPC alternative is chosen. If the ESPC alternative is the one chosen, this cost is already included in the payment schedule to the ESCO. For comparative analysis of all alternatives' implementation costs, the costs are discounted to FY17$ using a real discount rate of 0.50% from the latest OMB Circular A-94. This gives each alternatives' *NPV(Investment)*. Discount rates are discussed in the following sections.

B. RECURRING ANNUAL UTILITY SAVINGS

The energy baselines for the NAS Fallon project were provided to the ESCO by NAVFAC SW in 2015 for preparation of the IGA report. The ESCO prepared the IGA report with the assumption that energy usage would remain consistent from one year to another. The IGA report includes projected energy use for each ECM following completion of the ESPC alternative. Annual energy usage savings for the ESPC alternative are calculated as the difference between the baseline usage and the projected future usage. Annual energy savings are provided for electricity and LNG. As mentioned in Chapter IV, *Methodology*, all RMe ECM alternatives are assumed to have the same energy usage baseline as the ESPC alternative as well as the same annual energy savings. Energy savings are not realized until the FY following the award of a contract regardless of whether it is ESPC or RMe. This delay is from the time it takes for the construction phase.

Electricity is provided to NAS Fallon by NV Energy, LNG is provided by Southwest Gas., and utility rates are negotiated annually between NAVFAC SW and the local utility providers. For this analysis, FY17 utility rates were provided by NAS Fallon Public Works and will be used as the baseline rates. Table 7 summarizes utility usage pre- and post-implementation, along with FY17 utility rates.

Table 7. Summary of Utility Usage and Rates

Annual utility usage		Baseline	Projected	Savings	Rates, FY17
Lighting ECM	Electricity, kWh	2,618,590	1,430,458	1,188,132	$0.069/kWh
HVAC ECM	Electricity, kWh	2,587,098	1,114,256	1,472,842	$0.069/kWh
	LNG, MBTU	85,938	68,915	17,023	$8.32/MBTU

Adapted from Investment Grade Audit found in the Appendix.

The various alternatives introduced in the first chapter, and expounded upon in the next chapter, all start in FY17 having the same baseline energy use and utility rates. Depending on the alternative, one or both ECMs may be implemented in each FY. The following FY, the energy savings from the ECMs are realized through lower annual utility usage. This new, lower annual utility usage becomes the recurring annual usage throughout the remaining period of analysis. The cost of annual utilities in any FY is calculated by multiplying the annual utility usage components (electricity and LNG) by their respective utility rates for that FY.

Utility rates are escalated each year using a utility escalation rate, which is an output of a Department of Energy tool called the Energy Escalation Rate Calculator. This model applies specifically to ESPC type contracts. This analysis used the following parameters to determine the appropriate escalation rates for electricity rates and LNG rates:

- Fuel Type: Electricity and LNG
- Location: NV

- Sector: Commercial
- Start Date: 2017
- Duration: 20 years
- Policy Option: No carbon price
- Inflation rate (%): 2.00% (from OMB Circular A-94)

The Energy Escalation Rate Calculator tool calculates both real and nominal annual energy escalation rates. This analysis uses the real rates. For electricity, the tool calculated a real escalation rate of -0.29% which indicates that there is an expected localized trend in Fallon that electricity costs will decrease in future years. For LNG, it calculated a real escalation rate of 2.30%.

For each alternative being analyzed, costs from utilities in each FY are discounted to FY17$ using a real discount rate of 0.50% from the latest OMB Circular A-94. The annual discounted costs of utilities for each alternative are summed to find the total cost of utilities over the 20-year period of analysis. The Status Quo alternative never implements either ECM so its annual utility usage never decreases and it will have the highest total cost of utilities. The *NPV(Savings)* for all other alternatives is found by subtracting each alternatives' total cost of utilities over the 20-year period of analysis from that of the Status Quo alternative. The Status Quo alternative will also have a *NPV(Savings)* equal to zero and all other alternatives will have *NPV(Savings)* greater than zero.

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IV. METHODOLOGY

NAVFAC Publication 442 (P-442) is NAVFAC's *Economic Analysis Handbook*. The P-442 provides official Navy and NAVFAC guidance on how to prepare economic analyses for potential facility projects. Additionally, the P-442 provides guidance for program evaluation of ongoing projects. This analysis is concerned with the former. The focus of this analysis will be the "pre-expenditure" phase of a course of action, so an economic analysis in accordance with P-442 will assist decision makers in determining the best course of action. The P-442 follows the direction of OMB Circular A-94, "Guidelines and Discount Rates for Benefit-Cost Analysis of Federal Programs."

A. P-442 ECONOMIC ANALYSIS PROCESS

The P-442 Economic Analysis Process has seven steps:

1. Define the Objective based on planning actions and project scope
2. Generate Alternatives
3. Formulate Assumptions
4. Determine Costs and Benefits
5. Compare Costs and Benefits and Rank Alternatives
6. Perform Sensitivity Analysis
7. Results and Recommendations

Following the steps outlined, this analysis conforms to the P-442's Fundamental Planning Analysis process to conduct a Return on Investment (ROI) analysis using the Savings to Investment Ratio (SIR) technique. This analysis will not be a life cycle cost analysis of the alternatives.

The SIR calculates the savings gained from each dollar invested in an alternative. Mathematically, the SIR is the Net-Present Value (NPV) of the Savings divided by the NPV of the Investment.

$$SIR = \frac{NPV(Savings)}{NPV(Investment)} \tag{2}$$

For this analysis, the *NPV(Savings)* is defined as the reduced amount of annual expenses of an alternative as compared to the status quo's annual expenses. The *NPV(Investment)* is the present value of the facilities improvement cost of an alternative. A SIR greater than one represents an alternative that is cost effective. The alternative with the greatest SIR value will be the preferred alternative. Sensitivity analysis will be used to test the validity of assumptions used in calculating the SIR for alternatives.

B. ALTERNATIVES UNDER CONSIDERATION

This analysis will consider five alternatives for proceeding at NAS Fallon. A short description of each follows, with a fuller description after that.

1. **Status Quo Alternative:** Do not award the energy project as an ESPC now or as an RMe in the future and just operate the existing lighting and HVAC equipment for the duration of the analyses' timeframe. This Status Quo alternative is the baseline against which all alternatives are being compared.

2. **ESPC Alternative**. Award the energy project as an ESPC.

3. **Lighting ECM Alternative**. Award only the lighting ECM portion of the energy project as an RMe contract in FY20; the existing HVAC equipment and usage scheme will be maintained and operated for the duration of the analysis timeframe.

4. **HVAC ECM Alternative**. Award only the HVAC ECM portion of the energy project as an RMe contract in FY20; the existing lighting will be operated and maintained for the duration of the analysis timeframe.

5. **Lighting/HVAC ECM Alternative**. Award the entire energy project as an RMe contract in FY20.

Each alternative will be evaluated over a 20-year period of analysis. The cost considerations to the Navy include only facilities investment costs for implementation, and recurring annual utility costs for the duration of the analysis. Each alternative will be analyzed using the same factors: timeline to award, implementation costs, and utility escalation rates.

1. Status Quo Alternative

The Status Quo alternative is the least likely outcome of the decision-making process. In this case, the ESPC is not awarded and neither of the ECMs from that energy project will be performed with RMe funding during the 20-year period of analysis. The existing lighting and HVAC systems will be retained for the duration of the analysis.

The Status Quo alternative has no facilities investment costs since it continues to use the lighting and HVAC systems that are currently in place. No components will be added to the HVAC system and the controls configurations will remain as they currently are.

The annual energy use from the Status Quo alternative will not change from the baseline usage established in FY15. The annual energy cost will only change based upon inflation and utility escalation rates. The NPV of the Status Quo's total cost of utilities will be the baseline to compare every other alternative's NPV of recurring annual utility costs.

2. ESPC Alternative

The ESPC alternative is to proceed with awarding the NAS Fallon ESPC to the ESCO. It is the alternative under consideration by CNIC. CNIC must decide if they are willing to commit to annual payments to the ESCO to cover the cost of the energy project. The finance period for this ESPC is 12 years.

Prior to construction, the ESPC alternative requires the ESCO to prepare a full design of the energy project based on the work they performed during the IGA in addition to more detailed field surveys of existing conditions. The ESCO will use its contracting expertise to seek out qualified subcontractors to perform the work of design and construction that it cannot support in-house.

The ESPC alternative's facilities investment cost comes in the form of debt to the ESCO for the finance term of the ESPC. Annual payments to the ESCO account for the ESPC administrative costs, investigation and design costs, construction costs, commissioning costs, measurement and verification costs, ESCO profit, and interest payments. The first annual contractor payment will occur when construction is complete and the project has been accepted by the Navy. The final annual payment will occur at year 12, at which point all facilities investment costs will be expensed.

The ESPC alternative provides a performance guaranteed annual savings in energy usage, however, annual cost savings from utilities will not occur immediately. Annual payments to the ESCO will come from the utilities budget of Installation Commanding Officers, not from an RMe type of appropriation. Annual payments to the ESCO will be equal to the estimated annual cost savings from the ECMs so the annual utility budgets for CNIC will effectively be the same as the baseline year, 2015. CNIC will not see a real decrease in its NAS Fallon utilities budget until after the ESPC 12-year finance period, at which point, CNIC will realize the full annual savings from the ESPC energy project.

For this analysis, from year 12 to year 20 CNIC will have annual savings in energy usage and annual cost savings from utilities.

3. Lighting ECM Alternative

The Lighting ECM alternative does not award the ESPC. Instead, the Lighting ECM alone will be awarded with RMe funding in FY20. The delay in awarding the RMe accounts for the time it will take to develop the project in-house within the Public Works Department at NAS Fallon and request the funding. The scope of work for the construction of the Lighting ECM alternative will match the scope of the lighting ECM in the ESPC alternative. The HVAC ECM will not be performed at any point during the analysis timeframe.

From a technical standpoint, this alternative is well within the capabilities of the local Public Works Department at NAS Fallon meaning the lighting ECM can more easily be awarded than the HVAC ECM. The Public Works Department engineering teams will be responsible for conducting design surveys and project design for the lighting ECM. The contracting officer’s team will prepare the requirements for the work and contract with one or more contractors to perform the work. Upon acceptance of the completed work, the Navy assumes full responsibility for the new lighting systems.

With the Lighting ECM alternative, there are no facilities investment costs until FY20. In FY20, the implementation costs for this alternative will include in-house planning and design costs, construction costs, contingency costs, and administrative costs. These costs are paid for with RMe appropriated funding so all facilities investment costs are covered in the beginning, unlike the ESPC alternative that is financed for several years. No components will be added to the HVAC system and the controls configurations will remain as they currently are.

For the first three years of the analysis, the annual energy use the Lighting ECM alternative will not change from the baseline usage established in FY15. In that time, the annual energy cost from both ECMs will only change based upon inflation and utility escalation rates. Starting in FY20, the annual energy usage and energy cost will decrease from the lighting ECM alone, while energy usage and cost for the HVAC systems will not decrease.

4. HVAC ECM Alternative

The HVAC ECM alternative does not award the ESPC. Instead, the HVAC ECM alone will be awarded with RMe funding in FY20. The scope of work for the construction of the HVAC ECM in this alternative will match the scope of the HVAC ECM in the ESPC alternative. The lighting ECM will not be performed at any point during the analysis timeframe.

The technical requirements for this ECM could challenge the local Public Works Department engineering expertise based on input from the NAS Fallon installation Energy Manager (Justin Sielsch, personal communication). Lack of in-house skill related to HVAC retrofits would require substantial effort by Public Works Department to achieve the same scope of work as the ESPC alternative's HVAC ECM. The planning, design, and construction phases are the same as described for Lighting ECM alternative.

With the HVAC ECM alternative, there are no facilities investment costs until FY20. In FY20, the implementation costs for this alternative will include in-house planning and design costs, construction costs, contingency costs, and administrative costs. These costs are paid for with RMe appropriated funding so all facilities investment costs are covered in the beginning, unlike the ESPC alternative. No changes will be made to lighting.

For the first three years of the analysis, the annual energy use from the HVAC ECM alternative will not change from the baseline usage established in FY15. In that time, the annual energy cost from both ECMs will only change based upon inflation and utility escalation rates. Starting in FY20, the annual energy usage and energy cost will decrease from the HVAC ECM alone, while energy usage and cost for lighting will not decrease.

5. Lighting/HVAC ECM Alternative

The Lighting/HVAC ECM alternative is the combination of the Lighting ECM alternative and the HVAC ECM alternative. Both ECMs will be performed on the same RMe Task Order in FY20. The scope of work for each ECM will match the scope of work for the ECMs in the ESPC alternative. The relative simplicity or difficulty of meeting the technical requirements of each ECM is the same as in the Lighting and HVAC ECM alternatives.

For the Lighting/HVAC ECM alternative, there are no facilities investment costs until FY20. In FY20, the implementation costs for this alternative will include in-house planning and design costs, construction costs, contingency costs, and administrative costs. These costs will come from RMe appropriated funding so all facilities investment costs are covered in the beginning.

For the first three years of the analysis, the annual energy use from the Lighting/ HVAC ECM alternative will not change from the baseline usage established in FY15. In that time, the annual energy cost from both ECMs will only change based upon inflation and utility escalation rates. Starting in FY20, the annual energy usage and energy cost will decrease from both ECMs.

C. ASSUMPTIONS AND LIMITATIONS

This section will discuss the assumptions used in the analysis as well as the justification for doing so. The second part of this section discusses the major limitation in this analysis: exclusion of sustainment costs for alternatives.

a. Assumptions

(1) Timeline for Period of Analysis of Alternatives

NAVFAC P-442 requires a period of analysis of 40 years for energy projects and the design of new buildings. If the expected life of an energy system is less than 40 years, the period of analysis should equal the life of the energy system. For this analysis, there are several energy systems involved and they have varying lifespans. Additionally, the Status Quo alternative does not have any energy system improvements for which we can attribute a lifespan. This analysis will select a period of analysis of 20 years since the lifespans of the components within each ECM are less than 40 years. By the 20-year mark, all construction costs will be spent and the annual utility rates will have stabilized well before that.

(2) Timelines for Later Funding with RMe

RMe funding is a subset of the Navy's O&M budget. This O&M budget is planned for through the federal government's Planning, Programming, Budgeting, & Execution process. This process follows a three-year cycle in which programs and projects are planned for at least three years before they are funded by Congress. For this analysis, if the ESPC alternative is not selected, the earliest that any RMe funded alternative could be funded would be three years from now. The assumption of this analysis is that RMe alternatives will be funded in FY20 and no sooner. This assumption will be tested in Chapter V, *Results*.

(3) Scopes of Work and Completion Timelines Under RMe Alternatives

The ESPC alternative consists of two independent ECMs. The requirements of each ECM within the ESPC alternative were only loosely described to the ESCO by the

Navy. The ESCO used its own expertise and industry knowledge to refine the final scope of the two ECMs with input from the Navy throughout the process. With this finalized scope of work for the two ECMs, the ESCO could design an engineered solution for the ESPC alternative as described in Chapter II of this analysis, *Background and Literature Review*.

This analysis assumes that RMe funded ECMs will have the same scope of work and engineering design solution as the ESPC alternative. Additionally, the timeline for completion of design and construction of the ECMs is assumed to be the same, regardless of whether the ECM is financed through the ESPC or if it is funded via RMe. The Appendix, Investment Grade Audit, indicates a design/construction timeline of approximately one year from the date of project award. For analysis purposes, this means that if the ESPC is awarded at the start of FY17, the Navy will begin recognizing energy savings one year later in FY18. Conversely, if an RMe project is awarded in FY20, the Navy will begin recognizing energy savings in FY21.

(4) Energy Savings Under RMe Alternatives

Following closely upon the previous assumption, this analysis assumes that the energy saving in MBTU/year for each ECM will be the same regardless of whether the ECM is financed through ESPC or funded via RMe. Over the entire period of analysis though, total energy savings will differ depending on when an ECM is completed.

(5) Formulation Rates

This analysis assumes that the same formulation rates are appropriate for all alternatives. These rates are the discount rate, inflation rate, and utility escalation rates. Chapter III, *Data and Derivation of Costs and Benefits*, will discuss the values of the rates used and their sources. Chapter V, *Results*, will test the assumptions about how the formulation rates impact the analysis of alternatives.

b. Limitations

The major limitation of this analysis is annual sustainment costs for the equipment and components installed as part of each ECM. The post-acceptance sustainment costs are readily available for the ESPC alternative. The IGA report prepared by the ESCO shows the annual payments to the ESCO from the Navy. These annual payments are broken down to show how much goes to cover the actual implementation portion (plus interest and profit) and how much covers the post-acceptance sustainment portion of the ESPC alternative. The post-acceptance sustainment cost shows the operations and maintenance cost for the installed ECMs during the finance period which goes from FY18 to FY28. Beyond FY28, the Navy is responsible for all future sustainment costs.

For the non-ESPC alternatives, there is no usefully comparable sustainment data and costs available for analysis. NAS Fallon has a Base Operations Support Contract that handles the routine operations and maintenance of the base lighting and HVAC systems. The specific costs incurred in maintaining each system are not broken out in a way that is useful for comparing the Navy's Base Operations Support Contract sustainment costs against those of the ESCO. The Base Operations Support Contract would be responsible for operations and maintenance activities for all non-ESPC alternatives for the entire duration of the analysis. Additionally, the Base Operations Support Contract would assume responsibility for operations and maintenance activities for the ESPC alternative starting in FY29 and continuing for the duration of the analysis. Due to the limited Base Operations Support Contract sustainment data, this analysis will not include operations and maintenance costs aside from utility costs. Chapter V, Results, will discuss the cost impact of including the known sustainment cost from the ESPC alternative.

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V. RESULTS

The previous chapters presented the sources of data analyzed as well as the methodology of the analysis. This chapter will present the results of the analysis as well as a sensitivity analysis of the results. All monetary values have been normalized to FY17$ using a real discount rate of 0.50% obtained from OMB Circular A-94.

A. COSTS, BENEFITS, AND PRESENT VALUE SUMMARIES

Table 8 summarizes the numerical results of the analysis. Note that the "SIR" row is a ratio, not a cost.

Table 8. Summary of Results, FY17$M.

	Alternative				
	Status Quo	ESPC	Lighting ECM	HVAC ECM	Lighting/ HVAC
POA Utility Costs	23.6	17.2	22.5	19.4	18.2
NPV(Savings)	0.0	6.3	1.1	4.1	5.3
NPV(Investment)	0.1	5.1	1.6	4.1	5.6
Utilities&Implement-ation	23.7	22.3	24.1	23.5	23.8
SIR	0.00	1.25	0.68	1.01	0.96

Adapted from CNIC, unpublished data.

The analysis results show that the Status Quo alternative has a "Utilities & Implementation" cost of $23.7M. This alternative has the greatest cost for utilities over the period of analysis. Additionally, since the Status Quo alternative is the basis for calculating each alternative's *NPV(Savings)*, this alternative shows zero savings. Lastly, this alternative has the least cost of implementation since there is no construction associated with it. This alternative, like all non-ESPC alternatives, does incur the cost of performing the IGA report in FY17.

The ESPC alternative has a total cost of $22.3M over the period of analysis. Of all five alternatives, the ESPC alternative has the least total cost over the period of analysis.

This is due primarily to the *NPV(Savings)* achieved, which is the greatest of all alternatives. The ESPC *NPV(Investment)* is the cost of implementing both ECMs, and this alternative is the less costly of the two alternatives that implement both ECMs. Most importantly, this alternative has the greatest SIR of the alternatives, which indicates that the ESPC alternative is the best investment within the period of analysis under the present assumptions.

The Lighting ECM alternative has the lowest implementation cost of the non-Status Quo alternatives. Unfortunately, it also saves the least in utilities and has the worst SIR of the non-Status Quo alternatives. Its SIR indicates a negative ROI over the period of analysis. The data suggests that given a longer period of analysis, this alternative could be viable, but that extended period of analysis likely exceeds the useable life of this ECM.

The HVAC ECM alternative appears to be the second best alternative of the group. It and the ESPC alternative are the only two that have a SIR greater than one, thus a positive ROI of the period of analysis. Annually, this alternative saves 22,049 MBTU when implemented at a cost of $4.1M. This equates to a MBTU unit savings cost of $186/MBTU-saved annually, which is the lowest of the alternatives. Compare this to the ESPC alternative with a cost of $194/MBTU-saved annually.

The Lighting/HVAC ECM alternative is the costliest alternative to implement, coming in at approximately $500,000 more than the ESPC alternative. The *NPV(Savings)* of this alternative are second only to the ESPC alternative. The difference in the savings between these two alternatives is caused by the three-year difference in implementation dates. Once implemented, this alternative saves as much in energy costs as the ESPC alternative on an annual basis. This alternative does have a negative ROI over the period of analysis, however, a slightly longer period of analysis would give this alternative a positive ROI. This alternative suffers from the poor ROI that is contributed by the lighting ECM.

B. SENSITIVITY ANALYSIS

This chapter will test several assumptions discussed in Chapter IV, *Methodology*. The first two sections of this chapter test assumptions that only affect alternatives where

ECMs are implemented with RMe funding; Timeline to Award the RMe Project and RMe Project Costs. The next two sections test assumptions related to all project alternatives; Formulation Rates and Sustainment Costs. The last section of this chapter is discussion of a simple Monte Carlo simulation in which the assumptions are simultaneously tested except for Sustainment Costs.

a. *Timeline to Award RMe Alternatives*

The original assumptions in this analysis regarding timelines is that any RMe funded alternative would be awarded no sooner than FY20 which is three years from now. This would put the project planning in line with the DOD's standard Planning, Programming, Budgeting, & Execution cycle. Full implementation of the project would occur one year later in FY21, at which point the Navy would begin realizing energy savings.

For this sensitivity analysis, the award timeline for each of the RMe funded alternatives was moved back one year at a time starting from FY20. All other assumptions were held constant. Table 9 shows the results of this analysis. As expected, as the timelines are moved closer to the present, each alternatives' SIR value improves because of the earlier realization of energy savings. The Status Quo and ESPC alternatives are included for comparison, although they are not being tested. None of the alternatives exceed the SIR of the ESPC alternative.

Table 9. Test of Timeline of Award for RMe Funded Projects, SIR Values

Alternative	FY20	FY19	FY18	FY17
Status Quo	0	0	0	0
ESPC	1.25	1.25	1.25	1.25
Lighting ECM	0.68	0.73	0.77	0.82
HVAC ECM	1.01	1.07	1.12	1.18
Both ECMs	0.96	1.01	1.07	1.12

Adapted from CNIC, unpublished data.

b. RMe Implementation Costs

Chapter III, *Data and Derivation of Costs and Benefits*, discussed how the implementation costs for each ECM were arrived at for an RMe funded project. From the best regressed equation, in FY17$ the expected project cost for the lighting ECM is $1.5M. The Standard Error from the best lighting ECM CER is $69,283. The expected project cost for the HVAC ECM is $4.1M. The Standard Error from the best HVAC CER is $414,890. The cost of the ESPC alternative in FY17$ is $5.1M. Of this cost, approximately 20% accounts for implementation of the lighting ECM and 80% accounts for implementation of the HVAC ECM.

Table 10 shows the best and worst cases for the ECMs' implementation costs as compared to the costs of the ESPC alternative. The best-case scenario is most relevant and the analysis shows that the total implementation cost of the lighting and HVAC ECMs minus their respective Standard Errors is on par with the ESPC implementation cost. The lighting ECM is still significantly costlier than its ESPC alternative, however, the HVAC ECM is much less costly than its ESPC alternative. Ultimately, the ESPC alternative is less costly than even the best-case scenario in which both ECMs are awarded as an RMe funded project.

Table 10. ECM Implementation Cost -/+ SE, FY17$.

	CER Cost	SE	CER + SE	CER - SE	ESPC
Lighting	1,497,124	69,283	1,566,407	1,427,841	1,011,760
HVAC	4,052,837	414,890	4,467,727	3,637,947	4,047,041
Total	5,549,961	484,173	6,034,134	5,065,788	5,058,801

Adapted from CNIC, unpublished data.

Table 11 shows the SIR values of each RMe funded alternative in a best-case and worst-case scenario for implementation cost. As expected, in a best-case scenario, each alternatives' SIR value improves because of the less costly implementation cost. Conversely, SIR values saw a drop in the worst-case scenarios. The Status Quo and ESPC alternatives are included for comparison, although they are not being tested. None of the alternatives exceed the SIR of the ESPC alternative.

Table 11. Test of Implementation Cost for RMe Funded Projects, SIR Values.

Alternative	CER Case	Best-Case	Worst-Case
Status Quo	0.00	0	0
ESPC	1.25	1.25	1.25
Lighting ECM	0.68	0.71	0.65
HVAC ECM	1.01	1.12	0.92
Both ECMs	0.96	1.05	0.88

Adapted from CNIC, unpublished data.

c. Utility Escalation Rates

The utility escalation rate affects all the alternatives. From the Energy Escalation Rate Calculator developed by the Department of Energy, the real utility escalation rates for electricity and LNG are -0.29% and 2.30% respectively. This analysis assumes that these rates are reliable for duration of the period of analysis. To test this assumption, the utility escalation rates were manipulated individually to find the point at which the ESPC alternative no longer has the best SIR as compared to the RMe funded alternatives. Additionally, the ESPC alternative's overall NPV [*NPV(Investment)-NPV(Savings)*] is tested against that of the Status Quo alternative since it does not have a SIR greater than zero.

Table 12 summarizes the findings from testing the utility escalation rates. Each rate was decreased individually to find the point at which at least one alternative had a greater SIR or smaller overall NPV in the case of the Status Quo. For both electricity and LNG, the Status Quo alternative eventually overtakes the ESPC alternative as the best alternative when the utility rates are decreasing. Next, the escalation rates were individually increased from their starting values. For electricity, the escalation rate reaches 10.6% before the Lighting ECM alternative has a better SIR than the ESPC alternative. For LNG, the escalation rate reaches 11.5% before the HVAC ECM alternative has a better SIR than the ESPC alternative.

Table 12. Test of Utility Escalation Rates

	Decrease	Increase
Electricity	-6.4%	10.6%
LNG	-3.5%	11.5%

Adapted from CNIC, unpublished data.

These escalation rates are unrealistic. Annual escalation rates of these magnitudes would quickly result in either negative utility costs or unbearably high utility costs. Within a reasonable range of plus or minus a 200% change in magnitude, neither utility escalation rate causes an alternative other than the ESPC to be the best alternative over the period of analysis.

d. Sustainment Costs

This analysis has not accounted for sustainment costs from maintenance and repairs within the various alternatives because that data is not readily available for the non-ESPC alternatives. There is data available for sustainment costs for the ESPC alternative. These are sustainment activities that the Navy is paying the ESCO to perform during the 12-year finance period of the ESPC alternative. This data is found in the Appendix, Investment Grade Audit. The ESCO refers to these sustainment costs as Post-Acceptance Performance Period Expenses. Over the finance period of analysis, FY18 to FY28, these expenses amount to $1.3M in FY17$.

If the ESPC sustainment cost is included in the ESPC alternative's SIR, the SIR drops to 0.999 over the period of analysis. In this case, the Lighting/HVAC ECM alternative becomes equally as attractive as the ESPC alternative, however, that assumes that there are no sustainment costs for the Lighting/HVAC ECM alternative. That is an absurd assumption and it is safe to say that there will be sustainment costs for all alternatives. When those unknown sustainment costs are factored into the alternatives' costs, the ESPC alternative again comes out as the best alternative.

e. Monte Carlo Simulation

The assumptions for Timeline to Award RMe Alternatives, RMe Implementation Costs, and Utility Escalation Rates were simultaneously tested using a Monte Carlo simulation in Excel. The simulation was run 10,000 times. Random numbers were used to select values for each parameter as summarized in Table 13. For the timeline parameters, a random number corresponds to a probability range for a given number of years to award the RMe project. The implementation cost for each ECM is assigned a random value between the calculated CER cost minus and plus the Standard Error. The utility escalation rate for each type of utility is assigned a random value between the original rate minus and plus a certain percentage. For electricity, it is -/+ 0.50%. For LNG it is -/+ 3.00%.

Table 13. Simulation Assumption Parameters.

Timeline to Award RMe					
Timeline to Award RMe	1 year	2 years	3 years	4 years	5 years
Probability	5%	10%	50%	25%	10%
RMe Implementation Cost					
Calculated CER Cost, FY17$		-SE	+SE		
Lighting ECM	1,497,124	1,427,841	1,566,407		
HVAC ECM	4,052,837	3,637,947	4,467,728		
Utility Escalation Rates					
Original value		Min. value	Max value		
Electricity	-0.29%	-0.79%	0.21%		
LNG	2.30%	-0.70%	5.30%		

Adapted from CNIC, unpublished data.

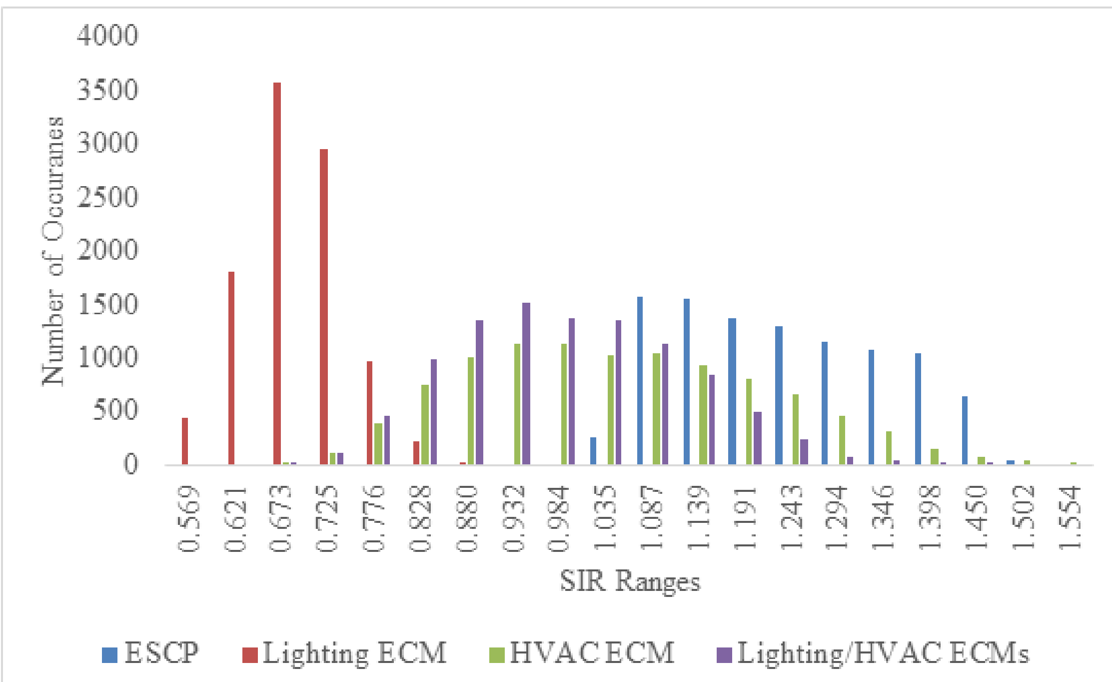
Table 14 shows that the simulation found similar results as those previously discussed in this analysis. The ESPC alternative typically has the best SIR value, although not always. The HVAC ECM alternative was the better alternative in 14.6% of the 10,000 simulations. The Lighting/HVAC ECM alternative was better in 2.6% of the simulations.

Table 14. Monte Carlo Simulation Results, SIR Values.

	ESCP	Lighting ECM	HVAC ECM	Lighting/ HVAC ECMs
Mean	1.26	0.72	1.07	1.01
Max	1.52	0.90	1.61	1.45
Min	1.06	0.57	0.71	0.71
Exceeds ESPC	--	0.0%	14.6%	2.6%

Adapted from CNIC, unpublished data.

Figure 2 is a histogram showing the frequency of observations of a particular SIR value within a small range. All four non-Status Quo alternatives are shown in the figure and are color coded according to the legend in the bottom of the figure. The non-ESPC alternatives appear to have a normal distribution while the ESPC alternative is skewed to the left.



Adapted from CNIC, unpublished data.

Figure 2. Histogram of SIR Results from Monte Carlo Simulation.

Since the Status Quo alternative does not have a useful SIR value, it was tested against the ESPC alternative using the overall NPV [*NPV(Investment)-NPV(Savings)*] for each alternative over the period of analysis. In 10,000 runs, the Status Quo alternative had a lower overall NPV than the ESPC alternative over the period of analysis in 5.4% of the runs. In this simulation, the Timeline to Award RMe Alternatives parameter did not play a part since it does not apply to the Status Quo alternative.

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VI. CONCLUSION

Throughout the DOD, energy use and energy efficiency at military installations is a high priority in infrastructure spending. Reduced spending on energy allows increased spending for operational needs that directly support the warfighter. NAS Fallon is pursuing an energy saving project for lighting and HVAC in several dozen of its facilities. The installation is proposing the use of an ESPC to finance the work rather than seeking RMe funding from the O&M,N budget. CNIC must approve the use of an ESPC since it financially obligates the Navy in the future. This analysis is intended to determine if the ESPC alternative is a worthwhile investment and to analyze the impact of not awarding the ESPC alternative if it is the best course of action. The findings from this analysis can supplement CNIC's decision making process on whether to reject the ESPC alternative.

This analysis looked at the ESPC alternative along with four other alternatives including the "do nothing" Status Quo. The methodology used for this analysis was established by NAVFAC and follows the guidance of the OMB Circular A-94. Return on Investment was the method used to determine the best alternative of the five.

All results from this analysis indicate that the ESPC alternative is the best decision for NAS Fallon. The ESPC alternative has the benefit of occurring immediately so the energy savings occur sooner than all other alternatives. Additionally, it has the benefit of a lower implementation cost for each ECM compared to similar NAVFAC energy projects. The HVAC ECM alternative is also a good decision, however, it has a smaller ROI than the ESPC alternative. The Lighting ECM alternative does not have a positive ROI and should not be considered for implementation. The HVAC ECM alternative does have a positive ROI and would be a good investment in the absence of the ESPC alternative. The combined ECMs have a favorable ROI and could be implemented via RMe funding in the future. Lastly, the Status Quo alternative is the least beneficial of the five alternatives and should not be considered a legitimate alternative.

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APPENDIX. INVESTMENT GRADE AUDIT

The Investment Grade Audit report was prepared by Ameresco for the U.S. Navy. The report is discussed in more detail in Chapter II, Section B.

SCHEDULE TO-1 (Final)

Guaranteed Cost Savings and Contractor Payments

IMPORTANT INFORMATION

(1) This schedule is not to be altered or changed in any way. Please note any clarifications in the comments/explanations area below.
(2) [Reserved]
(3) The guaranteed annual cost savings are based on the site-specific M&V plan.
(4) The total of annual contractor payments represents the TO price and should be supported by information submitted.
(5) If applicable, prior to the post-acceptance performance period, implementation period allowable payments and energy savings are one-time amounts only.
(6) The proposed guaranteed cost savings during the implementation period and post-acceptance performance period must exceed the contractor payments.
(7) Escalation rates were calculated using EERC 2.0-15. Electric escalation is 2.10%; natural gas escalation is 3.85%. The weighted average escalation rate is 2.79%.
(8) If selected, the contractor shall complete the installation of all proposed ECMs not later than 17 months after task order award.

Task Order No.: Final Task Order # TBD	Contractor Name: Ameresco, Inc.		Project Site: NAS Fallon
	(a) Estimated Cost Savings $	(b) Guaranteed Cost Savings $	(c) Contractor Payment $
Implementation Period	$ -	-	$ -
Post-Acceptance Performance Period Year	(d) Estimted Annual Cost Savings $	(e) Guaranteed Annual Cost Savings $	(f) Annual Contractor Payments $
ONE	$ 612,372	612,372	$ 612,371
TWO	$ 629,480	629,480	$ 629,479
THREE	$ 647,111	647,111	$ 647,110
FOUR	$ 665,282	665,282	$ 665,281
FIVE	$ 684,011	684,011	$ 684,010
SIX	$ 703,317	703,317	$ 703,316
SEVEN	$ 723,218	723,218	$ 723,217
EIGHT	$ 743,735	743,735	$ 743,734
NINE	$ 764,888	764,888	$ 764,887
TEN	$ 786,698	786,698	$ 786,697
ELEVEN	$ 809,187	809,187	$ 362,639
TWELVE	$ -	-	$ -
TOTALS	$ 7,769,299	$ 7,769,299	$ 7,322,741

Explanations/Comments:

SCHEDULE TO-3
Post-Acceptance Performance Period Cash Flow

Project Site:	NAS Fallon	Task Order No.:	Final Task Order # TBD	Contractor:	Ameresco, Inc.

Project Capitalization		Applicable Financial			
		Index	Interpolated UST		
Total Implementation Price (TO-2 Total)	$ 4,318,102	Index Maturity (Years)	6.6	Issue Date:	16-Dec-16
Plus: Finance Procurement Price ($)	$ 158,197	Index Rate	2.32%	Source:	www.bloomberg.com
Less: Implementation Period Payments (from TO-1)	$ -	Added Premium	1.50%	Effective Through:	N/A
Total Amount Financed (Principal)	$ 4,476,299	Project Interest Rate	3.82%		

Term: 11 years		Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Totals
Annual Cash Flow (Post-Acceptance Performance Period)														
Debt Service:														
Principal Repayment ($)	$ -	$ 490,589	$ 364,864	$ 378,811	$ 408,542	$ 440,315	$ 473,412	$ 508,756	$ 545,736	$ 532,342	$ 369,080	$ 163,103	$ -	$ 4,476,299
Less incentives (i.e., REC's, White Tags, etc.)	$ -													$ -
Net principal repayment before interest		$ 490,589	$ 364,864	$ 378,811	$ 408,542	$ 440,315	$ 473,412	$ 508,756	$ 545,736	$ 532,342	$ 369,080	$ 163,103	$ -	$ 4,476,299
Interest ($)		$ 15,521	$ 155,041	$ 106,354	$ 141,807	$ 125,717	$ 108,799	$ 90,187	$ 70,410	$ 49,195	$ 38,500	$ 6,361	$ -	$ 948,455
Total Debt Service (a)	$ -	$ 506,112	$ 520,404	$ 533,165	$ 550,349	$ 566,032	$ 582,211	$ 598,943	$ 616,126	$ 581,537	$ 398,488	$ 169,464	$ -	$ 5,424,752
Post-Acceptance Performance Period Expenses														
Management/Administration ($)	$ -	$ 790	$ 811	$ 833	$ 833	$ 877	$ 901	$ 925	$ 949	$ 976	$ 1,000	$ 1,027	$ -	$ 9,948
Maintenance & Operation ($)	$ -	$ 32,300	$ 11,650	$ 33,072	$ 36,311	$ 38,929	$ 39,967	$ 41,346	$ 42,764	$ 107,832	$ 109,848	$ 112,759	$ -	$ 599,647
Repair & Replacement ($)	$ -	$ 26,150	$ 14,806	$ 25,455	$ 26,138	$ 26,831	$ 27,543	$ 28,275	$ 29,021	$ 29,790	$ 30,570	$ 31,380	$ -	$ 303,997
Measurement and Verification ($)	$ -	$ 9,136	$ 9,440	$ 9,690	$ 9,947	$ 10,211	$ 10,481	$ 10,759	$ 11,044	$ 11,337	$ 11,637	$ 11,946	$ -	$ 115,689
Permits and Licenses ($)	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Insurance ($)	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Property Taxes ($)	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Other ($)	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
SUBTOTAL Before Application of Indirect Rates	$ -	$ 86,417	$ 88,708	$ 91,088	$ 93,471	$ 95,948	$ 98,491	$ 101,101	$ 103,780	$ 149,115	$ 153,068	$ 157,121	$ -	$ 1,218,275
Indirect Cost Rate (%)	0.0%	16.0%	16.0%	16.0%	16.0%	16.0%	16.0%	16.0%	16.0%	16.0%	16.0%	16.0%	0.0%	16.0%
Indirect Cost Applied ($)	$ -	$ 13,827	$ 14,193	$ 14,574	$ 14,955	$ 15,352	$ 15,759	$ 16,176	$ 16,605	$ 23,858	$ 24,490	$ 25,139	$ -	$ 194,928
SUBTOTAL Post-Acceptance Performance Period Expenses	$ -	$ 100,244	$ 102,901	$ 105,662	$ 108,427	$ 111,300	$ 114,249	$ 117,277	$ 120,385	$ 172,973	$ 177,558	$ 182,260	$ -	$ 1,413,197
Profit Rate (%)	0.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	0.0%	6.0%
Profit Applied ($)	$ -	$ 6,015	$ 6,174	$ 6,338	$ 6,506	$ 6,678	$ 6,855	$ 7,037	$ 7,223	$ 10,378	$ 10,653	$ 10,936	$ -	$ 84,792
Total Post-Acceptance Performance Period Expenses (b)	$ -	$ 106,259	$ 109,075	$ 111,998	$ 114,933	$ 117,978	$ 121,104	$ 124,314	$ 127,608	$ 183,349	$ 188,208	$ 193,196	$ -	$ 1,497,989
TOTAL - ANNUAL CONTRACTOR PAYMENTS (a) + (b)	$ -	$ 612,371	$ 629,479	$ 645,163	$ 665,281	$ 684,010	$ 703,314	$ 723,257	$ 743,734	$ 764,887	$ 586,697	$ 362,659	$ -	$ 7,022,741

Explanation/Comments:

1) Post-Acceptance performance period expenses shall include only direct costs and no implementation period expenses.
2) Contractor shall attach adequate supporting information detailing total performance period expenses (direct costs).

3) If applicable, contractor shall specify escalation rate applied to performance period expenses. The applicable escalation rate is 2.67%.

4) If applicable, see Implementation Period Payments from TO-1(Final).
5) Indirect expenses are applied to the sum of the direct post-acceptance performance period expenses. Profit is applied to the sum of the post-acceptance performance period expenses, which include direct and indirect expenses.

SCHEDULE TO-4

Task Order Performance Period First Year Estimated Annual Cost Savings, by Energy Conservation Measure and Technology Category

IMPORTANT INFORMATION

1) Project Square Footage (in 1000 SF) - Include only building square footage by installed ECMs in project.
2) For column (a), insert estimated energy baseline by ECM and total project in Mbtu based on IGA and proposal data.
3) For column (c1), annual electric demand savings (kW/yr) is the sum of the monthly demand savings.
4) Energy conversion factors for MBTU: MBTU= 10^6 BTU; Electricity - 0.003413 MBtu/kWh; Natural Gas - 0.1 MBtu/therm.
5) Specify "Other" energy savings in (e1) and (e2) as applicable: N/A.
6) This schedule is not to be altered or adapted in any way. Please note any clarifications in the comments/explanations area below.

Project Site: NAS Fallon | Delivery Order No.: Final Task Order # TBD | Contractor: Ameresco, Inc. | Project Square Footage (KSF): 2,242

Task No.	ECM No.	Description	(a) ECM Energy Baseline (MBTU/yr)	(b1) Electric Energy Savings (kWh/yr)	(b2) Electric Energy Savings ($/yr)	(c1) Electric Demand Savings (kW/yr)	(c2) Electric Demand Savings ($/yr)	(d1) Natural Gas Savings (MBtu/yr)	(d2) Natural Gas Savings ($/yr)	f= .003413*b1 +d1 + e1 Total Energy Savings (Mbtu/yr)	g= b2+c2+d2+e2 Total Energy Cost Savings ($/yr)	(h) Other Energy Related and O&M Cost Savings ($/yr)	(i) Water Savings (k-gal/yr)	(j) Water Savings ($/yr)	k = g+h+j Estimated Annual Cost Savings ($/yr)	(l) Implementation Price $	m = l/k Simple Payback (yrs)
	IGA	Investment Grade Audit and Final Proposal	-	-	$ -	-	$ -	-	$ -	-	-	$ -	-	$ -	$ -	$ 100,291	N/A
TC-3	1	Lighting Upgrades	8,915	1,188,132	$ 163,032	-	$ -	-	$ -	4,055	163,032	$ -	-	$ -	$ 163,032	$ 902,314	5.5
TC-4	2	Controls & Motors	94,766	1,472,842	$ 204,578	-	$ -	17,023	$ 242,762	22,049	447,340	$ -	-	$ -	$ 447,340	$ 3,510,278	7.8
TOTAL			647,893	2,660,974	$ 368,610	-	$ -	17,023	$ 242,762	26,105	$ 611,372	$ -	-	$ -	$ 611,372	$ 4,516,082	7.4

Explanations/Comments:

(1) The cost savings shown in Schedule TO-4 above have been escalated by the agreed upon escalation rates such that they represent the Performance Period Year 1 Estimated Annual Savings and support the Estimated Annual Savings shown in Column (d) on Schedule TO-1(Final) for Year One.

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